CLAIMS

We claim:

1. A method for detecting and quantifying impairments of a received communication signal of a quadrature amplitude modulation (QAM) data communication system represented by a plurality of ideal values, said method comprising the steps of:

a) storing a statistically significant number of a plurality of received points of said signal for each of said ideal values corresponding to a plurality of groups of said plurality of ideal values, each of said received points being defined by an in-phase and a quadrature components in a coordinate system in which a first axis is an in-phase axis and a second axis is a quadrature axis, said components having corresponding ideal components from their respective of said ideal values, each of said groups corresponding to a respective of said impairments and being specific to the same;

b) analyzing said components of said received points of respective of said groups in relation with their respective of said ideal components of said ideal values to quantify said impairments of said signal and provide calculated values of the same;

c) displaying said calculated values of said impairments.

2. A method as defined in claim 1, further comprising, after step c), the following step of:

d) storing said calculated values of said impairments, thereby allowing an unmanned monitoring of said communication signal.

3. A method as defined in claim 1, wherein said impairments are selected from a group including signal compression ratio, I/Q gain imbalance ratio, I/Q phase imbalance, phase noise, signal to noise ratio, signal to interference ratio and clipping level.

4. A method as defined in claim 3, wherein said plurality of ideal values being distributed around an origin of said coordinate system in a plurality of adjacent rows and columns forming a square shape pattern, said rows and columns being in a direction of said in-phase axis and said quadrature axis respectively, said pattern defining four outer corner ideal values, external horizontal and vertical ideal values of said two outermost of said rows and two outermost of said columns respectively, internal ideal values in a center proximity of said origin, different combinations of said received points corresponding to respective of said defined ideal values forming said plurality of groups.

5. A method as defined in claim 4, wherein said received points corresponding to respective of said four outer corner ideal values forming a first of said plurality of groups corresponding to said signal compression ratio impairment, said method, further comprising, after step b), the step of:

b1) determining for each of said four outer corner ideal values an average received point from the corresponding of said plurality of received points, a radial component of a vector going from corresponding of said outer corner ideal value

to the corresponding average received point, and a signed average of said radial components, the ratio of the latter to a nominal distance from said origin to one of said outer corner ideal value being said signal compression ratio of said signal.

6. A method as defined in claim 5, wherein said received points corresponding to respective of said external horizontal and vertical ideal values forming a second of said plurality of groups corresponding to said I/Q gain imbalance ratio impairment, said method, further comprising, after step b1), the steps of:

b2) determining for each of said external vertical ideal values an average received point from the corresponding of said plurality of received points, an in-phase component of a vector going from corresponding of said external vertical ideal value to the corresponding average received point, and a signed average of said in-phase components;

b3) determining for each of said external horizontal ideal values an average received point from the corresponding of said plurality of received points, a quadrature component of a vector going from corresponding of said external horizontal ideal value to the corresponding average received point, and a signed average of said quadrature components, a ratio of said signed average of said in-phase components to said signed average of said quadrature components being said I/Q gain imbalance ratio of said signal.

7. A method as defined in claim 6, wherein said received points corresponding to respective of said external horizontal and vertical ideal values forming a second of said plurality of groups corresponding to said I/Q phase

imbalance impairment, said method, further comprising, after step b3), the steps of:

b4) determining for each of said external horizontal ideal values an average received point from the corresponding of said plurality of received points, an in-phase component of a vector going from corresponding of said external horizontal ideal value to the corresponding average received point, and a second signed average of said in-phase components;

b5) determining for each of said external vertical ideal values an average received point from the corresponding of said plurality of received points, a quadrature component of a vector going from corresponding of said external vertical ideal value to the corresponding average received point, and a second signed average of said quadrature components, a ratio of said second signed average of said quadrature components to said second signed average of said in-phase components being a tangent value of said I/Q phase imbalance of said signal.

8. A method as defined in claim 7, wherein said received points corresponding to respective of said four outer corner ideal values and two middle of each of said external horizontal and vertical ideal values forming a third of said plurality of groups corresponding to said signal phase noise impairment, said method, further comprising, after step b5), the steps of:

b6) determining for each of said four outer corner ideal values four sub-average received points of four subgroups from the corresponding of said plurality of received points, said four subgroups dividing the corresponding of said plurality of received points into four adjacent areas divided by two perpendicular

lines respectively parallel to said in-phase and quadrature axis and intersecting each other at an average received point of the corresponding of said plurality of received points, said four sub-average received points forming two substantially tangential and radial segments of a respective ellipse having a respective length difference;

b7) determining for each of said middle ideal values four second sub-average received points of four second subgroups from the corresponding of said plurality of received points, said four second subgroups dividing the corresponding of said plurality of received points into four adjacent areas divided by two perpendicular lines respectively at a forty-five degree (45°) angle from said in-phase and quadrature axis and intersecting each other at a second average received point of the corresponding of said plurality of received points, said four second sub-average received points forming two substantially tangential and radial second segments of a respective ellipse having a respective second length difference, and a total average of all of said length and second length differences with said second length differences being increasingly weighted by essentially a square root of two factor, a ratio of said total average to the distance of one of said four corner ideal values to said origin being said phase noise of said signal.

9. A method as defined in claim 8, wherein said received points corresponding to respective of said innermost ideal values forming a fourth of said plurality of groups corresponding to both said signal to noise ratio and signal to interference ratio impairments, said method, further comprising, after step b7), the steps of:

b8) determining for all of said innermost ideal values a distance between said plurality of received points and its corresponding of said innermost ideal values, a histogram distribution of said distances which substantially follows a normal distribution, and an average signal amplitude being an average of all distances of each of said plurality of said ideal values of said signal to said origin;

b9) statistically determining best match values of said histogram distribution with a plurality of predetermined standard deviations and offsets of a peak of a respective normal distribution from a zero distance to determine a true standard deviation (σ) and a true offset (A) by interpolating between said predetermined standard deviations and offsets around said best match values, ratios of said true standard deviation and said true offset to said average signal amplitude being said signal to noise ratio and said signal to interference ratio impairment of said signal respectively.

10. A method as defined in claim 9, wherein in step b9) said best match values being statistically determined using a least mean square method, and said true standard deviation and true offset being determined using linear interpolation method.

11. A method as defined in claim 9, wherein said fourth of said plurality of groups also corresponding to said clipping level impairment, said true standard deviation (σ) and true offset (A) corresponding to a true normal distribution, said method, further comprising, after step b9), the step of:

b10) determining a cumulative probability of occurrence of said distances being larger than a two true standard deviation (2σ) distance from a center of

said true distribution, a true quantity of said occurrence, and a clipping ratio of said true quantity to said cumulative probability of occurrence, said clipping level being “clipping likely”, “clipping” and “severe clipping” upon said clipping ratio between two and four, four and eight and larger than eight respectively.

12. A method as defined in claim 11, wherein said signal being represented by a specific coding, said signal parameters are selected from a group including real baud rate, real carrier frequency, amplitude and group delay response, and low frequency disturbance (hum), said method further detecting and quantifying said signal parameters, said method further comprising, after step c), the steps of:

d) storing a statistically significant number of a plurality of operating parameters available and extracted from a signal demodulator of a receiver of said signal;

e) analyzing said plurality of operating parameters to quantify said signal parameters of said signal and provide calculated values of the same;

f) integrally displaying said calculated values of said signal parameters.

13. A method as defined in claim 1, wherein said method being non-intrusive of said signal an adapted for an in-field signal detection at a receiver end of said data communication system, said statistically significant number being between eight thousand and sixteen thousand.

14. A method for detecting and quantifying parameters of a received communication signal of a quadrature amplitude modulation data

communication system represented by a specific coding, said signal parameters are selected from a group including real baud rate, real carrier frequency, amplitude and group delay response, and low frequency disturbance (hum), said method comprising the steps of:

a) storing a statistically significant number of a plurality of operating parameters available and extracted from a signal demodulator of a receiver of said signal;

b) analyzing said plurality of operating parameters to quantify said signal parameters of said signal and provide calculated values of the same;

c) integrally displaying said calculated values of said signal parameters.

15. A method as defined in claim 14, further comprising, after step b), the steps of:

b1) counting a MPEG (Motion Picture Expert Group) stream word rate over a specific time duration of an order of magnitude of one second from said plurality of operating parameters;

b2) determining a signal user bit rate and consequently said real baud rate parameter of said signal using said MPEG word rate and said specific coding, said real baud rate impairment being accurate within an accuracy of a counter time base of said demodulator.

16. A method as defined in claim 15, wherein said operating parameters include a control word and a control word dimensional factor, said method further comprising, after step b2), the steps of:

b3) performing a re-sampling of said operating parameters to recover an actual baud rate of said signal;

b4) determining said real carrier frequency parameter of said signal from said actual baud rate using a numerically controlled frequency generator having an output frequency being related to said actual baud rate by multiplying the latter (actual baud rate) by an average of said control word and dividing by said control word dimensional factor.

17. A method as defined in claim 16, wherein said signal being filtered by an equalizer of said receiver of said data communication system to compensate for linear distortions of said signal using complex coefficients, said distortions being frequency responses, phase responses and reflections, said operating parameters further include said complex coefficients from said equalizer, said method further comprising, after step b4), the step of:

b5) determining said amplitude and group delay response parameter of said signal by calculating an amplitude and a phase from said frequency responses and a group delay from said phase responses of said equalizer respectively using said complex coefficients.

18. A method as defined in claim 17, wherein said signal being related to a power line, said method further comprising, after step b5), the steps of:

b6) synchronizing a spectrum analyzer to said power line having a frequency and first harmonics being order of magnitude less than a frequency of said signal;

b7) sampling sequences of an amplitude of said signal with a resolution bandwidth of a same order of magnitude as said signal using a typical functionality of said spectrum analyzer;

b8) triggering said sequences to said frequency and first harmonics of said power line and averaging the same;

b9) determining said low frequency disturbance (hum) parameter of said signal by zooming on small amplitude modulation of said averaging to extract a peak-to-peak modulation.

19. A method as defined in claim 18, wherein said peak-to-peak modulation varies between one tenth (0.1) of a percent and fifteen (15) percent.

20. A method as defined in claim 19, wherein said method being non-intrusive of said signal an adapted for an in-field signal detection at said receiver, said statistically significant number being between twenty (20) and two hundred (200).